DARWIN'S MARVELOUS IDEA
The role of creativity in the evolution of life

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ABSTRACT: According to Darwin, the complexity of organic structures can be understood as the effect of a blind algorithmic process of step-by-step accumulation of design forced by natural selection. That is why the materialist philosopher Daniel Dennett calls Darwin's theory «dangerous» for the religious belief in a divine creator. However, one can doubt whether Darwin has banished all teleological thinking from biology. In the view of the Frankfurt theory of evolution, organisms can be conceived as machines existing for the reason of gaining the energy necessary for their further existence. This definition underscores that organisms exist for their own sake; they are, as Kant puts it, ends in themselves. So, it is not the mere contingency of variation and selection but the subordination of these processes under the intentionality of self-perseverance, which in the end generates the form of a living being. From such a perspective, the various traits of animal design can be conceived as manifestations of a sort of creative power, which converts Darwin's theory into a marvelous idea even for the religious believer.

KEY WORDS: evolution, creativity, natural selection, evolutive design, divine creator, religious believe.

La maravillosa idea de Darwin:
El papel de la creatividad en la evolución de la vida

RESUMEN: Según Darwin, la complejidad de las estructuras orgánicas se puede entender como el efecto de un proceso algorítmico ciego de la acumulación progresiva del diseño forzado por la selección natural. Por eso el filósofo materialista Daniel Dennett llama la teoría de Darwin «peligrosa» para la creencia religiosa en un creador divino. Sin embargo, uno puede dudar de que Darwin haya desterrado todo el pensamiento teológico de la biología. En el punto de vista de la teoría de la evolución de Frankfurt, los organismos pueden ser concebidos como máquinas existentes con el objetivo de obtener la energía necesaria para su existencia continua. Esta definición pone de relieve que los organismos existen por su propio bien, ya que son, como dice Kant, fines en sí mismos. Por tanto, no es la mera contingencia de la variación y la selección, sino la subordinación de estos procesos en orden a la intencionalidad de auto-mantenimiento, que al final genera la forma de un ser vivo. Desde tal perspectiva, las diversas características del diseño de los animales pueden ser concebidas como manifestaciones de una especie de poder creativo, que convierte la teoría de Darwin en una idea maravillosa, incluso para el creyente religioso.

PALABRAS CLAVE: evolución, creatividad, selección natural, diseño evolutivo, creador divino, fe religiosa.

Introduction

In 1995, Daniel Dennett, one of the leading representatives of the philosophy of mind in the USA and lately known for his bestseller *Breaking the Spell. Religion as a Natural Phenomenon*, published an introduction to evolutionary thinking entitled «Darwin's Dangerous Idea». This title is a little irritating, because although scientific theories can be many things: generally accepted or controversial, current or outdated, elegant or boring, perhaps even true or false – how should they be dangerous? Normally, we are used to finding such an attribution in an ideological context. It is plainly clear that it is Dennett's intention to refer to such a context. For him the most important significance of Darwin's theory is that it has overturned the generally shared conviction that material design (i.e. a material constellation of of a certain degree of both complexity and purposefulness) calls for an

intelligent author, and that this principle is as valid for living beings as for artifacts. Doubtless, even before Darwin people were well aware that living beings differ form artifacts in their way of generation. They are not products, but rather organize themselves according to a specific program. However, this developmental program does not show less intentionality than the production of, let us say, a chair by a carpenter, and likewise calls for an intelligent cause. «No design without a designer.» Obviously, in the case of development nobody would assert that an animal could act according to proper plans or intentions, and not adhere blindly to an intrinsic program. But all the same, the developmental program of an animal being highly sophisticated, and the animal not capable of being its own author, the conclusion is inevitable that there must be an extrinsic cause intelligent enough to generate such a program. That is in general the conclusion leading to the conviction that it is mind which determines the arrangement of matter. Before Darwin, materialistic thinkers did not know how to overcome this fundamental tenet. That is why Dennett cherishes Darwin's theory as a scientific and even philosophical revolution because «in a single stroke the idea of evolution by natural selection unifies the realm of life, meaning and purpose with the realm of space and time, cause and effect, mechanism and physical law» [1]. It is providing a mechanism, or more exactly, an algorithm by which the purposefulness of organic acquisitions can be explained as a step-by-step accumulation of design no longer in need of any intelligent planner. «Here, then, is Darwin's dangerous idea: the algorithmic level *is* the level that best accounts for the speed of the antelope, the wing of the eagle, the shape of the orchid, the diversity of species, and all the other occasions for wonder in the world of nature. It is hard to believe that something as mindless as an algorithm could produce such wonderful things» [2]. Indeed, it *is* hard to believe. It is my hope that at the end it becomes clear what I think Dennett is ignoring in his view of natural selection. But first let us simply state that according to this view mind is no longer the basis of evolutionary complexity, but appears, if at all, as its climax. Instead of being its prerequisite mind is now «emerging» from material preconditions. There is no doubt that such an idea must be regarded as «dangerous» by any religious believer because a God who is no longer the Creator of the world «must either be turned into a symbol for something less concrete or abandoned altogether» [3].

Dennett's flaws

However, such a global interpretation based on ideological prejudice rather than on historical authenticity is not very convincing. Even more, it is far removed from Darwin's own intentions. Although Darwin regarded himself an agnostic and in his old days confessed his color-blindness in religious matters, this so-called atheism neither rose from the foundation of his theory, nor was it something he inflicted on his followers. For example, Darwin's correspondent Asa Gray was a famous American zoologist who fully embraced Darwin's theory of natural selection but at the same time was convinced that it had to be seen in a theological context. And the best example of a 20th century «theistic evolutionist» is the geneticist Theodosius Dobzhansky, who along with Ernst Mayr, Julian Huxley and J. B. S. Haldane is considered to be one of the founders of the «modern synthesis» of evolution theory. So Dennett's atheistic interpretation of Darwinism is both

[1] Dennett, D. C., *Darwin's Dangerous Idea*, Touchstone, New York, 1996, p. 21.
[2] Ibid., p. 59.
[3] Ibid., p. 18.

historically and substantially incorrect. Besides it is staggering how Dennett takes it for granted that the mind-body problem has already come to a reductive solution. The many competing theories existing in this field show that we still are as far from a satisfying solution of the problem of how mind can emerge from matter as we were in the days of Dubois-Reymond's *ignorabimus* [4].

However, there is a second reason why Darwin's idea might be dangerous to any metaphysical interpretation of nature, and this reason has to be taken much more seriously because it really is pivotal to Darwin's theory: the elimination of teleology. It seems that the explanatory power of natural selection has put an end to the need for final causes in nature. This is indeed a delicate subject, and both the philosophical view of man and the theological concept of creation depend a lot on how to cope with it. Needless to say, Dennett shares Darwin's opinion that teleology is obsolete in science, and so this must be the point from which our reasoning has to start.

Darwin does not completely deny that there is teleology in the realm of living nature. How could he? Every textbook on biology provides us with lots of examples for how purposefully living beings are designed. However, Darwin gives us another explanation for this. In his opinion, the apparently purposeful design of organisms is nothing but the unintended, yet inevitable, consequence of the process of natural selection. There is no need for a process-defining, intentional agent if the design of living beings results from successive random accumulation. In contrast to development, the process of evolution is not determined by a specific end, and to that extent there is no place for the introduction of a final cause. That is the doctrine which, having been continuously repeated for the past 150 years, has the quality of a dogma.

What, then, is really expressed by the formula that purposeful organic structures can be generated by means of natural selection? The idea is that the struggle for existence favors such structures and properties that are *advantageous* or *useful* to its bearer. – What else is this but a teleological proposition? It does not only describe an effect that natural selection has, but also indicates that there must be a subject (*subiectum,* in Latin) that the properties in question are useful or advantageous to. So, it is not the mere algorithm of natural selection by which design is generated, but by the reference of this algorithmic process to a subject deriving benefit from the effects of this process. In what does this benefit consist? According to Darwin, in the survival of the bearer of that design, that is, in the maintenance of its existence or in the propagation of its genes, respectively. Richard Dawkins, famous companion of Dennett in the battle for an atheistic world, tries to escape from this teleological context by referring natural selection to the changing frequency of gene combinations. At first glance, this strategy seems to avoid the implication of natural selection that organisms have to be seen as ends in themselves. But that is only half of the story. Gene frequencies cannot change and gene propagation does not work except as transported by organisms. That is why Dawkins conceives organisms as «gene vehicles», being no ends in themselves but simply serving as a means of gene propagation. Evidently, that is another teleological statement. 'Vehicle' is nothing but another expression for a machine, and machines are defined by their function, that is, what they are *good for*, and this is undoubtedly once more a teleological characterization. The function of the organism seen as a machine is the propagation of a gene combination, which is favored by natural selection because it contains the instruction for generating successful propagation machines of genes. So, in the end the elimination of the teleological proposition has

[4] Dubois-Reymond, E., *Über die Grenzen des Naturerkennens*, Veit & Co., Berlin, 1916.

failed, and the qualification of organisms as ends in themselves is re-established. Organisms are propagation machines of gene combinations for the production of new propagation machines. You cannot put it otherwise. But this is not an infinite chicken-or-egg regress. Genes can only be defined within the context of an organism, whereas it is possible to define an an organism without referring to its genes.

Organisms as hydraulic machines

To characterize the organism by a machine analogy is the specific mark of distinction of the so-called Frankfurt theory of evolution. This theory was elaborated at Senckenberg Museum, Frankfurt (Main) by Wolfgang F. Gutmann and others about 1970, partly as a reaction to the overemphasized adaptationism of the classic Darwinian view[5]. It never succeeded in influencing the current view of Darwin's theory (the so-called «modern synthesis»), but, on the contrary, was quite outlawed by the scientific community. Nevertheless I refer to it in what follows because as a matter of fact it is not opposed to Darwin's theory but rather is its endorsement. In 2010, D. S. Peters, one of the co-founders of the Frankfurt theory published a small book on evolution which, though less than 100 pages, is in my opinion the best explanation of Darwin's theory we actually have[6]. So it seems worthwhile dealing with this approach.

According to this theory animals are not only metabolic systems, but must be seen as hydraulic constructions as well. The most primitive cell already shows that. As the Latin «*cellula*», from which the term is derived, intimates, it is defined by a wall or, better, a membrane which isolates its interior from the surrounding medium, thus assembling a mixture of interacting compounds into a definite unit which can be identified through time and space. The shape of this unit (which in the simplest case is spherical) is determined by the antagonism of interior hydrostatic pressure and the elastic tension of the outer involucrum. Both the maintenance of the hydrostatic pressure and the metabolic reactions in the interior depend on a permanent supply of energy, forcing the cell to find appropriate nutrition sources. In the beginning, the primitive hydraulic construction can do nothing but to float in its medium, «hoping» to find some material to incorporate. Although it is a difficulty of its own how to introduce solid particles into an inflated balloon, the main problem the hydraulic construction has to solve is how to move actively to energy sources. For that purpose the interior pressure has to be channeled within an actively form-changing coat thus driving the whole construction ahead. It is precisely the combination of stabilizing and tethering fibers (= actin) with (energy consuming) motor proteins (= myosin) gliding along these fibers by which the effect of hydrodynamic motility is achieved.

This is why Peters in his definition of evolution calls organisms «operationally unified, material and energy transforming, mechanical coherent systems»[7]. It is the continuous flow of energy transformation from metabolic activity via biomechanical transmission to hydrodynamic propulsion, guaranteeing further energy supply, that characterizes the construction of a living machine. This «circuit of bionomy» must not be interrupted in any of its steps, neither in the course of development nor in that of evolution[8]. Only constructional

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[5] Gutmann, W. F. - Bonik, K., *Kritische Evolutionstheorie*, Gertenberg, Hildesheim, 1981.

[6] Peters, D. S., *Evolution. Die Theorie eines selbstverständlichen Prozesses*, Basilisken Presse, Rangsdorf, 2010.

[7] Ibid., p. 23

[8] Gudo, M. - Warnecke, W., *Evolutionstheorie und Kreationismus – ein Gegensatz* (Eds. O. Kraus), Franz Steiner, Stuttgart, 2009.

novelties which are compliant with that fundamental law (Greek: *nómos*) of organic life (*bíos*) will persist. So the way of evolutionary change is determined – and perhaps even predictable – by this law.

Here we meet once more with the circular definition of life we discussed above in the context of teleology. I have to admit that I myself was laughing at this implication when I got acquainted with Gutmann's theory for the first time. What should this concept be good for: living beings as machines able to move in order to get the energy they need for their movement? Now I am sure that we have to embrace this definition not only because of the implication of self-subsistence by which it can be rescued from being circular, but because of its reference to bionomy, too. Energy supply and construction can no longer be seen as two independent constituents of the organism, one referring to biochemistry, the other to morphology. Rather they must be understood as the characteristics of the unity of form and function, as biologist have long known. Form results from the ways by which a hydraulic construction can be shaped and driven energetically, and ongoing energy supply depends on whether or not the hydraulic construction is able to perform ways by which energy can be channeled.

This view of a coherent flow of energy transformation conditioned by form and change of form conditioned by energy has an enormous impact on both natural selection and evolutionary change. Because of their competition for energy, the «living machines» are permanently forced to improve motility. It is classic Darwinism that more efficient variants will be favored by natural selection, and need not further be discussed. But there is still the question of how such an improvement can be achieved. We remember that the plasticity of a hydraulic construction depends on the interaction of tethering elements and motor proteins in the deformable involucrum. It is the arrangement of those elements by which the way of biomechanical energy transformation and, in consequence, the motility of the whole construction is improved. This is shown by Gudo and Warnecke in an instructive diagram. At first glance, its message is clear: If you want to win the struggle for energy in the long run, you have to transform yourself from an amoeba into a ciliaphore, from this state into a worm and further into chordate, a fish and eventually into a tetrapod (a seal, as it seems). That looks like the simple view of increasing perfection in the idealistic sense of a *scala naturae.* However, a second look reveals that there is a guiding idea of constructional innovation behind that is completely mechanistic: Starting with the cytoskeleton of a protozoon, which allows for locomotion by pseudopodia as well as by cilia, the improvement of the tethering conditions permit an elongation of the hydraulic construction to a worm-shaped organism. Its undulating locomotion needs a hydroskeleton which results from channeling the interior hydraulic pressure within an epitheliomuscular tube. It only works effectively when the hydroskeleton is proportioned into a series of muscle-enveloped coelomic cavities, allowing even peristaltic movement. Eventually the hydroskeleton can be replaced by a form-stabilizing axial rod («chorda»), from which an inner skeleton with inserted limbs can be derived, which finally extends the facilities of living from solely aquatic to terrestrial and even aerial habitats. So runs the short story of vertebrate evolution, and it does not at all look like a contingent series of brute facts which unpredictably happened to occur, as Stephen J. Gould used to express it[9]. Rather it is the highly comprehensible narrative of constructional improvement due to both the competition for external energy supply and the economy of biomechnical energy transmission.

[9] Gould, S. J., *Wonderful Life. The Burgess Shale and the Nature of History*, W. W. Norton, New York, 1989.

Of course, vertebrate evolution is only one phylogenetic trait among many others, as the Senckenberg poster of animal evolution can show us. What we see in this poster is not a mere compilation of overwhelming diversity, as it may at first seem, but a strictly ordered array of multiple lines of constructional improvement, each of which tackling the problem of increased efficiency in a peculiar way. It differs greatly from the aspect of the classic tree of life we are accustomed to since the days of Ernst Haeckel. What is shown here looks more like an inverted shrub consisting of a bundle of equivalent branches rising simultaneously from a common origin. The endpoints of the branches represent a great variety of organization types which can not be brought into one scale of lower and higher complexity. To this extent, Gutmann and his proponents are right when they deny orthogenetic evolution in the sense of a continuous advancement of perfection. On the other hand, there can clearly be seen a general trend towards increasing perfection within each line. And to this extent, the anagenetic progression of evolution is basically orthogenetic, due to the dictate of bionomy each phylogenetic line has to respect. Putting it this way, the whole poster of animal evolution is turning into something like a depiction of award-winning solutions from an idea contest for designing energy-transforming hydraulic machines. Obviously, not all the solutions allow for locomotion, as there are various sessile types, too. In the past, these forms did not rely on elongation but conserved the radial symmetry of their ancestral forms, which favor a certain propensity for sessile life styles. This need not be a sign of less ingenuity. The elaboration of the body plan of an anthozoan comprises as many steps of constructional improvement as that of a primitive tetrapod. This is perhaps the most striking aspect of Gutmann's evolutionary thinking. (Of course, there are highly motile forms among actinomorphic animals as well, as the jelly fish can demonstrate.)

Five questions

It would be tempting to spend more time on pondering the peculiarities of this evolutionary view and discussing in detail some of its controversial assumptions – above all the derivation of multicellular animals from a hypothetical stage called «gallertoid» [10]. But let us concentrate here on five more principal questions.

(1) Is the Frankfurt theory of evolution still genuine Darwinism? Otherwise we would no longer marvel at Darwin's idea but at Gutmann's.

(2) If evolution is basically determined by the structural requirements of a hydrodynamic, energy transforming machine, is there still any room for accidental change? Could one deduce the direction and even the concrete steps of evolution from the premises of bionomy – without any knowledge of the forms which actually exist?

(3) Does the Senckenberg poster claim to give a real picture of what happened during the history of life, or is it a mere theoretical – and normative – schedule of how the different types of hydraulic construction can be brought into lines of increasing biomechanical functionality – no matter how these results were historically attained? To put it another way: Does this theory only attest the intelligence of organismic design, or does it also demonstrate the way by which this intelligent design has been achieved? It is the old philosophical distinction of *genesis* and *validity* that is

[10] Gutmann, W. F., *Die Evolution hydraulischer Konstruktionen*, W. Kramer, Frankfurt, 1989, p. 87.

behind this question. From the judgment that a certain constructional novelty is in compliance with the demands of functional improvement it does not follow that this novelty has originated because of that reason. This is nothing but the inversion of the insight that norms do not rise from facts.

(4) As the evolutionary change of design cannot be caused by constructional principles alone (they are the formal rather than the efficient cause, to put it in Aristotelian terms), the question has to be addressed if there is any teleological moment, by which the organisms are driven to increased complexity. The proponents of the Frankfurt theory agree that in the first place it is the organism's own activity which adjusts the direction of constructional improvement. As the 2nd question suggests, this may comprise random processes as well as intentional ones. Is there a way by which these two opposites can be brought together?

(5) And last but not least: Isn't there a logical fallacy behind this view of evolution? When we see organisms as hydraulic machines, the category of teleology is inevitably imported, for machines are functional entities and to that extent are teleologically designed, as we have seen. But then we must not wonder why organisms conceived in such a way call for a teleological explanation.

The answer to the *first question* is quite simple. It is true that Gutmann's theory is in contradiction to what in his terminology is called «ancient Darwinism» («Alt-Darwinismus»), which in his opinion involved understanding the effect of selection as exclusively adaptive to environmental conditions. However, the idea of bionomy by which Gutmann thought to overcome the adaptionist view does not work if not founded on the theory of natural selection, the essential part of which is the competition for resources. There would be no evolution of energy transforming machines at all, if organisms were not subjected to the selection pressure of gaining energy. What Gutmann is adding to the common Darwinist view is the relevance of *internal* selection. Prior to all external conditions it is the constitution of the organism itself which decides whether or not a constructional modification is viable, and consequently will show up as an evolutionary change.

The *second question* refers to the proportion of determination and randomness of evolutionary change. The very point of the Frankfurt theory of evolution is that a continuous enhancement of construction is inevitable because it is the compelling consequence of tackling the problem of energy support. At the beginning, or at the basis, of a certain level of organization there is normally more than one way in which the perfection of organization may advance. However, in the course of the ongoing improvement of that organization type, the number of directions still open to further evolution usually decreases because of the already accumulated constructional constraints. It is like remodeling the construction of a house. As long as the house consists of only a few rooms, and the surrounding garden is large, there are many ways of possible amplification. But after building a garage, erecting a second floor and adding a winter garden, most ways for future enlargement are closed. Similarly, to the hydraulic construction of a single-celled protozoan many ways of motility are open: besides simple pelagic floating there is propulsive locomotion facilitated by pseudopodia, by cilia, by flagella or even by undulating membranes (cf. *Trypanosoma*). Only the elongation to worm-shaped constructions is not permitted in the beginning because of the yet insufficient form-controlling power of the elastic involucrum. In contrast, after taking the course of becoming sessile the constructional plasticity will greatly be reduced. In the same way, the architecture of a metameric hydro-skeleton allows for many constructional pathways diversifying from quite similar original points but ending up in the singularities of highly different pathways. The reason for that is simply that the

modification of a construction type is always initiated on the mutational level, and that means at random. But further on, it is the internal selection that has to approve the mutational change according to the constraints of a given constructional context, and that is deterministic. That is why Gutmann has compared the course of evolutionary transformation to an avenue lined with broad margins of hydraulic malformations. What you will find at the borders is due to chance, but what you may encounter as viable constructions on the road is due to necessity [11].

From this insight into the facilities and limits of hydraulic transformation we can now turn to *question 3* and the real-historic validity of the Senckenberg poster. Obviously, this evolution map is constructed by applying the principles of engineering morphology to the problem of phylogenetic relationship. To that extent, it is a theoretical, and even, up to certain point, an idealistic deduction. It shows where evolution has to get to, but says little about the ways by which these ends will be attained. This is the reason for our distinction of *normative deduction* and *empirical reconstruction*. So, this map is first of all a deductive-nomological outline of morphological transformation and not an empirically obtained arrangement of paleontological data. However, the principles by which the pathways of this map are elaborated are completely congruent with Darwin's theory. So the Senckenberg poster tells us in which direction natural selection will work when coming into contact with bionomously constituted entities. To that extent, it is intended to depict the real course of at least bauplan evolution, and not only to subsume the variety of organisms under a morphological rationale. It shows that the many deviations from classic phylogenetic pedigrees are due to the different methods of comparing morphology based on considering the homology of single characters, and engineering morphology based on technical considerations of functioning. This methodological difference provides a lot of stuff for endless discussions among specialists which we need not bother about. Besides, the impossibility of deducing the course of evolution is caused by the contingency of basic constructional bifurcations, as discussed in the last paragraph. So it is impossible to construct a realistic tree of life by mere deduction. It would be interesting to know if the proponents of the Frankfurt theory could predict further steps of evolutionary progression out of the existing organization types, or if they take the extant types as the already ultimate advancement in the perfection the constructional conditions allow.

Next, we have to address the relationship of determination and teleology in the evolution of constructional design (*question 4*). We have already seen that living energy- transforming machines are compelled by natural selection to improve the conditions of auto-motility. The Senckenberg poster shows a great variety of solutions which independently provide answers to the demands of energy support. Is this variety sufficiently explained as the synergistic effect of constructional determination and mutational contingency, as the answer to the 2nd question may suggest? We have to keep in mind that the principles mentioned here do not *cause* anything but are the *conditions* under which the living entities are working. It is not mutation alone by which constructional change is caused, but by the integration of such irritation events into the whole context of organic form-giving – be it successful or not. And it is the activity of the organism by which this result is achieved. So, the proponents of the Frankfurt theory of evolution do not tire of emphasizing that constructional transformation is something the organisms perform autonomously, and not a mere effect they are subjected to. Because of such a statement, one might be tempted to presume some kind of organismic teleology behind the panoply of constructional solutions the tree of life

[11] GUTMANN, W. F., *Jahrbuch für Geschichte und Theorie der Biologie*, Vol. 4, Verlag für Wissenschaft und Bildung, Berlin, 1997.

presents. For that reason, the proponents of the Frankfurt theory make haste to affirm that it is mere teleonomy that gives such an intentional aspect to evolution. Teleonomy, in contrast to teleology, means that the direction of the evolutionary transformation process, although it is performed by the organisms themselves, is mechanistically determined by natural laws. Teleonomy is working due to a program, not to an intention. So, it only looks as if it were intended when organisms tend to a higher degree of constructional perfection, but in fact their form-changing activity is directed by the conditions of inner and outer selection. – After all we have learned about the reference of natural selection to teleologically constituted subjects, the issue of teleonomy appears unsatisfying.

The diachronic creativity of life

Accepting a teleological viewpoint, the Senckenberg poster presents itself as a demonstration of life's form-inventing ingenuity. Most biologists would fiercely contradict the idea that there is some kind of creativity in living beings, emphasizing that what specifies the transforming power of morphogenesis is all chaotic or at least stochastic, and hence talk about creativity would at the best be a metaphor, and a misleading one at that. Here, a comparison can help. Imagine an artist who has in mind to create a new masterpiece without knowing exactly what he wants to express. So he starts throwing color bags at a canvas, leaving what will result to chance. Most of the outcome will be pure rubbish, but among hundreds of such trial and error attempts may be one which matches his imagination or even the liking of an art dealer. (Something similar happened with the «works of art» of a painting chimp a couple of years ago [12]). Although the issue has to be called chaotic with respect to its method, we can apply the term 'creative' to it because of its meaningfulness to somebody. That is the point of our comparison. It is not only the mentioned integration of mutational change into the unity of organismic form that sets living morphogenesis apart from mere chaotic effects, but the reference to a subject to which it matters what these processes have accomplished. In the case of painting, it is the correspondence with the artist's intuition or affective state that converts a number of color spots into a relevant work of art. In the case of organic morphogenesis, it is the reference to the self-subsistence of the organism that converts blind form-modifying processes into relevant design. The design of the chosen art piece of our painter was not intended, except in the very general sense that he wanted to create something of which ahead of time he had no concrete idea. So it is in the case of evolutionary creativity. Organisms do not intend constructional transformation. They only intend to maintain themselves as living. But it is this intended self-maintenance which allows for a teleological interpretation of the autonomy of living beings transforming their constructional conditions in a bionomous way.

It is once more Daniel Dennett who is well aware of the difference of self-organization between living subjects and physical systems. Hence, he has coined the expression of «diachronic pseudo-intentionality» in order to characterize what we call the creative power of evolving organisms. That this process is 'diachronic' is obvious. In contrast to human agents, organisms can pursue the method of trial and error only in the course of generations. To this extent, their intentionality of achieving more suitable design is necessarily «diachronic». However, how is this intentionality to be understood as

[12] Morris, D., *The Biology of Art. A Study of the Picture-making Behaviour of the Great Apes and its Relationship to Human Art*, Methuen, London, 1962.

«pseudo»? «Pseudo» can signify «not yet perfect» or «preliminary», as in the case of the «pseudopodia» of an amoeba. In a second meaning, «pseudo» refers to «completely false», or «misinterpreted», or even «deceptive». (This corresponds with the original meaning of the Greek word *'pseudo'* = I am lying.) The question is whether we are obliged to take the apparent creativity of life in this latter, pejorative sense. If we do so and deny all possible precursors of intentionality in evolution, how can we ever be sure of the reality of intentional acts in our own mind?

Conclusion

The idea of a creativity of life opens a wide and promising scope to both philosophical and, especially, theological thinking. That is, no doubt, why I favor this idea. If somebody holds such a metaphysical outlook to be illicit – what better alternative does he suggest? Can we really abrogate the idea of creativity of life in order to conceive of organisms in a more scientific way? This is the moment to come back to the last, *5th question*, whether there is a hidden logical flaw in our reasoning. It is true that I have introduced the machine analogy knowing quite well that it is inevitably connected to teleology. But once more: can we dispose of it? I think that the machine analogy is the most reductionist interpretation level we can apply to living beings. Nothing less is adequate. We can describe organisms as living systems, and of course they are. But such a description would not be specific enough, as we have seen. They must be seen as definite hydraulic entities, hence subjected to the laws of thermodynamics and hydromechanics. This is a completely mechanistic comprehension of life, with nothing idealistic or esoteric about it. To such entities, Darwin's theory of natural selection is fully applicable. So, put on its right foundations, Darwin's theory in my opinion is far from being dangerous, but has to be appreciated as a highly fruitful, indeed a marvelous, idea.

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